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A PEER SHARING APPROACH TO MISSION PLANNING AND
DEVELOPMENT IN U.S. ARMY TACTICAL ENVIRONMENTS

by

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September 2002

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This thesis analyzes the technical and information management environment that United States Army heavy combat tactical units operate in and provides a solution for how the Army's software development community can assist these units in managing multiple sources of information. The computer hardware, software applications and network infrastructure are examined within this context to illustrate the difficulty that lower level tactical units face in receiving, processing and redistributing information in an automated environment. The thesis describes some of the systemic reasons, not readily apparent to higher level operational units, as to why lower level tactical units struggle to keep pace with all of the information they received. Platform-centric, stovepipe approaches have caused significant challenges for managing the flow of information to and from the tactical unit level. In addition, the pushdown approach to information distribution does not adequately address how the terminal level units in the distribution process receive and synthesize information from multiple sources.

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IN U.S. ARMY TACTICAL ENVIRONMENTS

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LIST OF ACRONYMS

COTS	Commercial Off the Shelf
DoD	Department of Defense
TRADOC	Training and Doctrine Command
FORSCOM	Forces Command
MSE	Mobile Subscriber Equipment
HMMWV	High Mobility Multi-purposed Wheeled Vehicle
S-1	Staff One
S-2	Staff Two
S-3	Staff Three
S-4	Staff Four
S-5	Staff Five
S-6	Staff Six
DA	Department of The Army

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I.   INTRODUCTION

A.   BACKGROUND

It is apparent that the United States has become, arguably, the most productive and economically competitive country in the post Cold-War era. The chief contributors to this growth has been the broad approach by the U.S. commercial private sector, civilian public sector and the U.S. Department of Defense (DoD) leveraging the power of computing, information and networking technology. By doing so, we have placed pressure on the research and development communities to constantly improve our collective bottom line. For the past twenty-five years, during the transition of the computer revolution into the information revolution, the DoD has taken advantage of efforts primarily driven by the commercial and civilian government sectors and applied the knowledge to military operational and tactical processes; with varying degrees of success.

One area of concern the DoD is currently looking into is the ability to share information smartly over operational/tactical networks. To this end, the services have developed their own system of battlefield sensors, computers, applications and network infrastructure to communicate, manage operations planning and execution. However many of these tools were developed with specific tactical functions in mind. Each functional platform operates independent of others: integration for the purpose of sharing was an afterthought. Attempts to re-engineer and fix this afterthought remain a prominent challenge for U.S. Army research and development community.

As the U.S. Army develops better software tools to collect and manage information essential to higher level units, lower, tactical-level staffs are being overwhelmed with information they do not need, making it difficult to discern the essential elements. This can potentially result in the information they receive and process to be inaccurate, obscured, unnecessarily redundant or untimely. To prevent this from occurring, lower-level tactical units need mission planning tools that are tailored to their specific operational domain. Development of information

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management applications for tactical-level units will help the U.S. Army realize the potential gains that both the computer and information revolution have long promised.

Computers have brought about critical changes in the everyday functions of our lives, from traffic management to commercial aircraft control functions. Thirty years ago we would not have imagined the possibility of commercial aircraft flying across the skies unmanned. Yet, because of embedded systems for flight control functions, Global Positioning Systems (GPS) for position feedback functions and onboard navigation systems integrating the position vector feedback into flight control functions for the aircraft, we know that automated flight is possible.

This, as an example of the evolutionary changes in our environment, dictates that we, as both influencers of and functionaries within our environment, have to dramatically change how we view our environment if we are to leverage any advantage from the changes to it. Every documented industry success can be partially attributed to understanding the changing environment and early adaptation of the potential advantages resulting from those changes.

1.   Information Synthesis and Decisioneering

Information synthesis and decisioneering are the 'new frontier' of the computer revolution. Synergy, as it relates to automation, is the art and science of leveraging multiple sources of information into better decisions administratively, strategically and operationally. It can also be described philosophically as the sum of the whole (of information) being greater than its parts. In this domain, the private sector may be ahead of both the government and the DoD. The reason for this may be the differences in expected benefits for corporations, public service institutions and military operations. Competition for the private sector can readily translate into bottom line results such as total geographic market share or gross revenue.

For public institutions, the purpose of the institution is to provide a service to the community, and automation should result in cost savings and efficiency.

However, this can be difficult to quantify because many components of the institution can influence the cost of running it. By the time the institution realizes the gain from a cost saving automation project, the savings may have already been spent elsewhere. If analyzing the budget figures alone is supposed to provide the feedback of cost saving measures, then the results will likely be buried under budget increases of other areas. The more influences there are on a budget, the more difficult it is to determine if cost savings measures are creating any positive results. Competition is also defined differently. Public institutions may be competing with their own past performance or with the performance of previously elected leadership of the institution.

2.   The U.S. Army and Information Management

Consider the U.S. Army, as an extension of the government and part of the military community. Leveraging information for the military has its own challenges. Utilizing mobile network concepts to share information for planning and executing wartime operations is unique because 'mobile' implies wireless communications whereas for a civilian business 'mobile' often means virtual private networking and remote access.

One of the military's goals in recent years has been to trim costs. However it has to be balanced with others performance goals such as winning our nations wars, and conserving the lives of soldiers and the resources of the U.S. Army.

How all of these performance objectives are measured is challenging and unclear. In addition, some of the objectives may conflict with one another. For example, smaller, lighter, faster deployed into a military action means lower cost for the operation, however it, also means increased risk to the deployed soldiers and possibly violating an important principle of war, namely Mass.

Ultimately, what the DoD, and for the purpose of this thesis, the U.S. Army should be focusing on are the force multipliers to gain competitive advantages on the battlefield. The current philosophical approach the DoD is implementing this is called Network-Centric Warfare (NCW); a computer to network integration paradigm. Knowledge-Based Warfare (KBW) is the information integration

development process designed to approach a point of effective knowledge sharing and semi-automated decision making on the battlefield. A realistic goal for the DoD is to ensure every function specific computer platform operates on a common high-level architecture to ensure integration of the network and information scheme.

B. PURPOSE

The purpose of the thesis is to demonstrate through available resources that a need exists to develop software tools that allow lower-level units to access mission planning information as it is being developed. Specified tasks can be distributed more effectively by modifying how the messages are sent to lower-level units from higher-level units. This thesis will also imply that a cornerstone component of network and knowledge based planning will be facilitating effective information sharing on tactical networks.

C. SCOPE

The scope of this research is focused on the mission planning processes of the U.S. Army. The intent is to analyze the logical and functional processes of the hierarchic communications scheme the U.S. Army uses in the past and illustrate the differences between these processes and processes that could be used as a combat multiplier.

Some of the questions this study intends to answer are: How does the U.S. Army share information between units to achieve information synergy? What data objects, created by an information process, can be shared, with other units participating in an operation? What data object need to be modified during the sharing process? What data objects benefit from controlling access?

D. METHODOLOGY

This study reviews the current hardware, software and networking capabilities of the U.S. Army. The research also illustrates solutions the U.S. Army employs to solve networking, information management and communications problems.

The organization structure of the combat staffs at the brigade-level is analyzed to illustrate how information is produced and currently distributed. In order to identify better ways to communicate between echelons, issues are identified in the current process. The output of mission planning becomes the input of the Troop Leading Procedures (TLP) process.

A review of available pertinent literature, the research will analyze and illustrate how the military employs technology to solve information management problems. This study analyzes current processes and offer solutions based on extending current information processes to the lowest units, which can tremendously benefit from shared information resources. The goal of this study is to argue the necessity for renewing interest in incorporating lower level tactical units into automated information processes, specifically for mission planning.

E.   ORGANIZATION OF STUDY

This study incorporates a literature review of the current background of DoD studies in network-centric and knowledge-based warfare to ensure these issues are sufficiently addressed. Additionally, current U.S. Army organizational and technological structures are analyzed in order to define the solution that this Thesis suggests about the current technical capabilities of the U.S. Army.

This study researches the current information distribution processes, used at tactical units at the brigade-level and below use to create a conceptual model to address the current shortcomings. An illustration of the shortcomings in the current model and a way of solving these shortcomings will be offered.

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II.   U.S. ARMY NETWORKING

A.   U.S. ARMY ORGANIZATIONAL STRUCTURE

1.   Functional

To understand how the U.S. Army can achieve information superiority, an understanding of how the U.S. Army is organized and how it operates is needed. The U.S. Army is a hierarchical organization, sometimes struggling to identify itself by function, operation and task organization. Some of the organizational concepts have legacy connotations, not necessarily fitting into the dynamic structure of joint force operations and task organization. However, they do have relevance as container organizations for the lower units contained within them. There are many containers within the U.S. Army. *Armies* contain *corps*, who, in turn, contain *divisions*. However, in today's operational environment, armies do not deploy as operational units and seldom do corps. They administratively track resources and personnel status, maintain facilities and real estate for training and advise operational commanders and national military advisors at the highest levels about what the deployable units need. Additionally, they support the maintenance and supply functions of their deployable sub-units. The functional structure begins at U.S. Army level. Armies generally contain two to three corps.

A corps has a similar history and function to an U.S. Army in that it does not deploy forces directly but it contains forces according to what is called a Table of Organization and Equipment (TO&E). The primary difference between corps and armies is their historical inclination towards a service branch such as Artillery, Infantry or Transportation. Some corps has fostered relationships with the Training and Doctrine Command (TRADOC). Usually when a soldier is recruited, trained and indoctrinated into the U.S. Army he or she is first introduced to a corps of affiliation. Most training installations in the U.S. Army have at least one corps affiliation. A corps often contains two-three divisions.

Divisions can deploy as operational units. Their functions are similar to corps with the added responsibility to expect to deploy forces, either as whole

units or as sub-unit allocations to operational commands within an area of responsibility (AoR). Divisions are generally associated with Forces Command (FORSCOM) similar to the way corps are affiliated with TRADOC. The contrasting factor is that TRADOC units do not deploy, they train soldiers in training commands for eventual assignment to FORSCOM sub-units, which do deploy. Divisions most often contain brigades.

Brigades are generally the smallest sub-unit of deployment in the FORSCOM structure. A brigade will have smaller sub-units, however brigades usually do not allocate battalions to areas of responsibility separately; unless it being attached to a receiving command that is already in an AoR. Primarily, this is because of the enormous amount of support functions that brigades provide to battalions. Brigades have a similar relationship to battalions like divisions have to brigades. The pattern repeats itself to companies and platoons. For expediency, assume that there is little difference in the relationships between senior, container organizations and their sub-units. In order to quantify what each of these unit terms means, the base case will be a tank platoon, which will be built into a division.

By U.S. Army TO&E structure, a tank platoon consists of four M1A1 Abrams main battle tanks with four crewmembers for each tank or sixteen personnel in a tank platoon. A tank company consists of three platoons or twelve tanks manned by forty-eight personnel. The company has additional support personnel and two additional tanks, one for the Company Commander and the other for the Executive Officer (the second in command of the company). The total personnel in the company is sixty-three. The following is a summary table of how this will builds to a tank division. This table does not mention all of the support vehicles and equipment.

Unit Level	Description	Quantification
Tank Battalion	A tank battalion contains 4 tank companies with 14 tanks and 63 personnel each, and a headquarters support company, which contains 330 support personnel, staff and battalion command group.	A tank battalion has 56 tanks including an additional two for the battalion commander and Battalion S-3. The number of personnel assigned is (63 X4) + 330 support personnel $\approx$ 582 personnel.
Tank Brigade	A tank brigade contains 4 tank battalions with 56 tanks, 582 personnel each, and a headquarters support company, which contained 430 support personnel, staff and brigade command group. Note: Additionally there is an artillery battalion, a support battalion and other attachments, which we will not add to our count for generality.	A tank brigade has 226 tanks including an additional two for the Brigade Commander and Brigade S-three. The number of personnel assigned is (582 X4) + 430 support personnel $\approx$ 2758. This does not reflect the true total of personnel assigned or attached to a brigade. Therefore the numbers are minimal representations.
Tank Division	A tank division, if it were deployed as an organic operational unit, would employ 4 tank brigades, possibly a fire support brigade, aviation assets and various combat support and service support attachments.	A tank division has approximately 906 tanks including an additional two for the Division Commander and G-three. The number of personnel assigned at this level varies greatly and begins to lose fidelity with the pattern up to this point. The core personnel who compose a tank division number around 15,000 personnel.

Table 1: Generalization of unit organization using tank units

Every person represented in the conceptual unit operates as part of a team, extracting unique information parts, which determines their specific missions. The smallest subcomponent of this structure is capable of planning missions is a tank platoon. Which means, minimally, that there can be 3 x 4 x 4 x 4 = 192 missions being planned for one division. Added to that, are the logistics support units at each level, the fire support units, close air support aviation,

reconnaissance missions, and medical support operations; creating several opportunities for communication failures.

2.   Culture

According to Paul Sass,

> The U.S. Army is currently undergoing a metamorphosis, one in which its traditional "legacy" communications systems are evolving to a complex interconnection of numerous technologies, each based heavily on commercial standards, practices and services made affordable by the civilian world.[1]

In the past fifteen years, the U.S. Army has experienced many facets of the evolution of computer networking in U.S. Army combat operations. The Army has learned much about the tremendous advantages computer networking technology can bring to the modern battlefield. It is still learning some expensive lessons about what computer technology cannot do, both 'not yet' and probably 'not ever'.

Some of the technology successfully employed by the Army has already been accepted as part of how the Army conducts military operations. Yet, the search continues for the next big technological advantage to propagate through research, development and procurement. Technology can solve many of the Army's situational awareness problems; however, a key question remains, '*what can you do for me now?*'

The most glaring irony, however, is while the U.S. Army is demanding much for the future of computer technology and automation, we actually still struggle to take full advantage of what computing and networking technology has already provided us. Some of the most basic concepts of productivity, which are common in most large civilian institutions and private corporations, are still propagating their way through middle and lower-level units of the U.S. Army.

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[1] Sass, Paul Communications networks for Force XXI Digitized Battlefield.

In many combat units and battalion level staffs, computers are used as glorified word processors with little understanding of the true productivity potential at their fingertips. Any use of information in more complex ways is ad-hoc and based on the individual skills of the users to use the commercial-off-the-shelf (COTS) productivity tools provided, such as Microsoft Office® or Corel Office Suite®, usually installed at assembly. Using and subsequently sharing information from compiled lists or databases is virtually non-existent.

For these units, there is very little open networking being used. In fact, for many combat units at the battalion level and below, productivity means not having to type the same report twice. Sharing information over an integrated client/server network means that everyone in the workgroup can benefit from the work accomplished by one. Comparing this de facto model to the current networking models in use today, tactical units, at best, employ computer and information technology as ad hoc peer-to-peer networks. On average documents are shared by removable storage disks. Each automation platform is responsible for its own war-fighting platform. Information sharing and formatting for compatibility is not done. The U.S. Army is a long way from developing and using shared information effectively in tactical-level units. Basic productivity, however, is where the U.S. Army can gain a tremendous battlefield advantage.

For the 'not yets', concepts that are waiting on the maturity of a particular technology, financial support from higher-units, or some other time extending obstacle, the U.S. Army can see the future but is frustrated by the inability to reach the goals. The revolution in technology is expensive. In order to refit the military to a new way of conducting war means retrofitting existing equipment with new capabilities while maintaining legacy compatibility, and technology insertion into new combat equipment. The costs have been staggering to the DoD. The current practice is developing new combat vehicle technology over a period of multiple decades and thereby spreading out (or hiding) the enormous cost of developing this equipment.

For the 'not evers', the U.S. Army, lacking in a wealth of knowledge of the technologies we are expected to use, struggles to understand why it cannot

make the technologies work, or work together, the way we envisioned that they should. There are political, doctrinal, financial and technical reasons that explain why Division Commanders cannot conduct real-time video teleconferencing with platoon leaders on the fly, a half-world away. However, part of the problem is that Division Commanders do not accept that some technical developments cannot or should not be undertaken. If a 'technical expert' is unfortunate enough to be tasked with making something that will not ever work (or will not work yet) technically possible, their choices are to pretend to attempt to make it work or risk losing their jobs. These futile exercises waste money, time and precious resources, and ultimately demonstrating things we already knew we could not do. This is not a technology issue but a culture and awareness issue.

The military has to contend with the costs of developing network-technology; training soldiers, and equipping them to use it. The U.S. Army is attempting to develop doctrine, which is a slow, tedious process that takes years to develop. Because the process is slow, the deployed technology may be obsolete by the time soldiers in the field actually incorporate them. Doctrine is very slow in a dynamic environment where the only constant is change and new technologies are being developed by a corps of contractors looking to take advantage of the current knowledge base of technologies.

Few would argue that the networking resources are not available. Most will argue that the U.S. Army has not figured out how to use them effectively nor have we developed well-defined doctrine on how to use them. The U.S. Army has not invested in targeted information management goals and it is as if they are still in the discovery phase. Typically, soldiers in the field become the agents of discovery. The U.S. Army receives a component of technology, receive basic exposure training on it and begin using it. True doctrine emerges from using the technology in the field to gain an advantage of some sort. The advantage may eventually be discovered through trial and error, generalized and incorporated into policies and procedures as to how the component should be used. Eventually, local policies and procedures find their way to training, field and doctrine manuals.

If this method is employed to computer technology and information management tool development, the full potential that the technology promises us may never be realized. The Army cannot leave computer technology's development to chance by hoping that soldiers in the field figure out how to use it effectively. Soldiers in the field with information management skills are rare and only have the authority to develop problems, which could be both local and global. The results are multiple solutions to computing problems, often incompatible with each other. To solve problems on a larger scale, global authority must drive the development of global solutions to global problems in order to, at a minimum, address compatibility issues that will arise.

B. THE U.S. ARMY AND INFORMATION TECHNOLOGY

1. Protocols

The communications software backbone of the tactical Internet is the Ethernet and X.25 packet switching capability of the mobile tactical network infrastructure. This packet switching is facilitated by Mobile Subscriber Equipment (MSE) switches, which are fitted into specialized communications HMMWVs. The MSE switches support voice circuit switching and data packet switching at each vehicle. These vehicles are issued one per combat brigade. During planning and execution of combat missions the vehicles are positioned strategically to provide coverage for voice and data exchange between end nodes. Also, by modifying the Domain Naming Services (DNS) to be a more distributed service, data and voice subscribers can operate, with minimal loss of connectivity, in a mobile environment, that mimics cellular service.

The routing hierarchy is sustained at the corps and above level. To compare it to a civilian model, logically, a corps level unit provides local 'Internet' service. Routing packets between different corps is similar to routing packets up to a regional service provider or possibly a national service provider to carry long haul messages to other corps or even back to the United States. The semi-open nature of this packet network capability means that packets can be switched, globally to any node, anywhere in the world that is affiliated with the network.

Essentially, this network infrastructure supports the routing of Internet Protocol packets implying that the civilian global Internet can carry these messages. This also implies that with the current communications standards, two nodes which are carrying the same port services and transport layer protocols can communicate data packets over the civilian internet.

2. Media

The DoD's garrison communications infrastructure is virtually the same infrastructure used by civilian organizations. The Army uses COTS routers and switches to carry data communications, globally. Installations use fiber-optics backbones and borrowed bandwidth on government and civilian satellite transceivers. Servers and clients are built with commercially available hardware and install Microsoft Operating Systems. If fact, most of the Department of the Army (DA) Information Technology professionals are commercially trained civilians who are hired by requisition. The requisitions explicitly state the desire for people trained and certified to commercial standards. They do not receive specialized training in military equipment and media.

The tactical communications model is different for obvious reasons. Most notably, building a static infrastructure is inefficient and counterproductive. Tactical units position themselves in a geographically distributed manner for survivability concerns. These same factors create obstacles to effective wired media connectivity and therefore more flexible solutions have evolved to help units maintain connectivity and communications.

A drawback to this infrastructure is that it is difficult to sustain. It is vulnerable to environmental obstacles such as the terrain, unit distribution, weather considerations, dirt and the wear and tear that comes with constantly being disassembled, moved and reassembled.

Maintaining tactical communications requires highly skilled networking and communications experts. The U.S. Army is feverishly attempting to train these experts at military and civilian colleges and universities across the country. Part of the challenge is training the appropriate technologies and another part is

retaining personnel to keep their skills current. Training service-members, in high demand skills, creates very marketable soldiers to civilian organizations. With profit motivation as the primary motivator, civilian organizations can afford to pay skilled technology experts far better than the military is willing to.

C.   SUMMARY

The technical infrastructure necessary to support data communications is currently fielded and available to tactical units in the field. If the U.S. Army takes the initiative to develop better information management solutions for lower level tactical units, it will take time to evolve to a point where information superiority is a central training and execution factor. However, the benefits of information superiority, efficient mission planning, and improved situational awareness remain unchallenged.

Because the tactical Army has the unique challenge of making technology work in a dynamic environment, more emphasis must be placed on integrating networking into the mission planning process. Without advanced planning on the battlefield, the reliability and availability of the network will suffer. If this occurs, the information that units depend on will prove unreliable and information technology, as a combat multiplier, will be dismissed as useless.

There are influencing factors becoming an information-based Army. Until the U.S. Army evolves as a technical culture, the U.S. Army will continue to struggle with using the technology in tactical environments. More specifically, the U.S. Army is going to have to recruit individuals who are technically savvy and incorporate the technology into the entire mission planning functions and products.

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III.   STAFF ORGANIZATION

A.   OVERVIEW

In order to understand the manner in which the U.S. Army distributes information in tactical operations, we need to evaluate the tactical environment, the staff organization and the functions the unit staff use to create the information. This is not only beneficial to understanding the current processes but also to understanding the sources of information. Understanding the sources of information makes it easier to transition to understanding how we can modify the information distribution processes to make the information provided more efficiently shared and distributed.

In the next chapter, evaluating the Military Decision Making Process provides a framework that can be generalized and ported to any size or type of unit. Assuming that the computing and networking framework is functional, these processes can be implemented as information distribution processes under a tactical network as easily as the current process of bringing all of the information developers together to distribute the information.

The staff organization is evaluated for reference only. The information this chapter is taken from the published Field Manual (FM) 100-5 Operations, 1993. In this study, the human role players execute a set of functions. The functions require teamwork, which dictates that every member of the team understand the tasks the team, as well as each team member, is expected to perform. The focus is not placed on the uniqueness of the staff members but on the functions they perform, the information they create and how it is distributed to other participants in their function.

Staff role players currently focus on their own functional analysis of missions and contribute their information to the core information products (discussed in the MDMP chapter) and specify tasks to their Battlefield Operating System (BOS) resources. BOS integration is based on coordination meetings with maneuver forces. Sometimes, but not necessarily within the formal meeting

processes between the brigade commander, his subordinate commanders and staff members.

1. Staff

The staff of a combat brigade is responsible to the Brigade Commander to aid him in managing the MDMP process. From the moment the brigade receives a warning order, an alert message that a mission will be coming their way soon, the clock begins and the staff begins to execute the mission planning and preparation tasks that they have been previously trained to do. Below is a discussion of a combat brigade's key staff members, their responsibilities to their commander, their BOS responsibility.

2. Organization

Figure 1 illustrates that the Brigade Commander has three staff components, each covering different sub-domains within the commander's overall responsibility. The coordinating staff is responsible for the coordinating the operations and resource management of combat operations. The special staff personnel are attached or assigned to the brigade to support the commander's mission as combat multipliers. These personnel generally act as liaisons between combat support commands and maneuver commands.

Where there is a reference to a 'J' or a 'G' staff position, the meaning attached to the position is Joint staff or General Officer Staff position. Joint means inter-service and General refers to high-level staff positions such as division level and above.
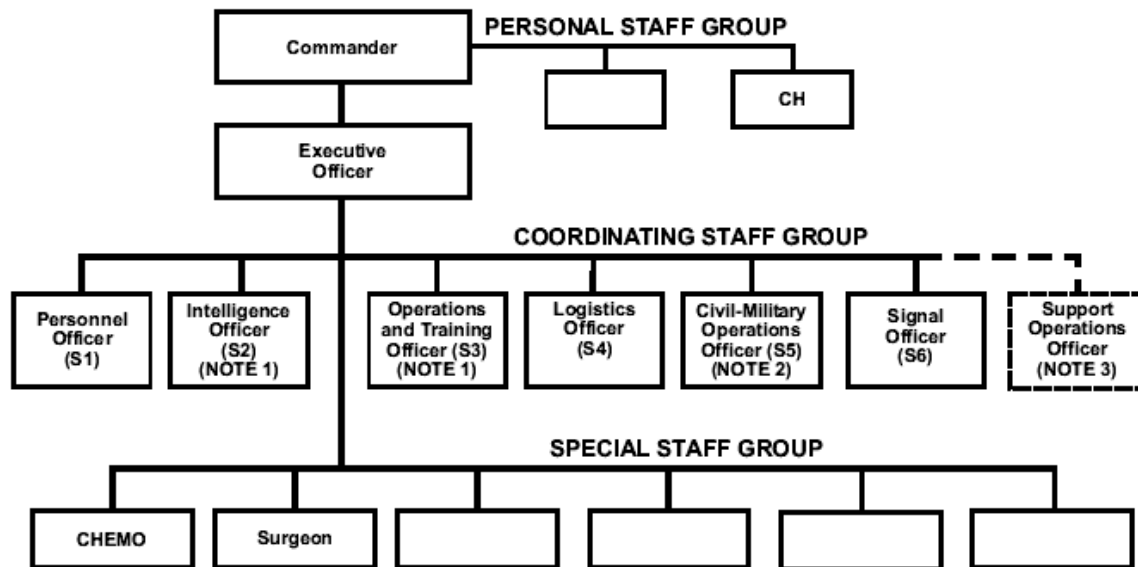
Figure 1: Staff Organization Chart from FM 100-5

3.   PERSONAL STAFF

Personal staff members are assigned or attached to a command, to advise a commander on issues and concerns that may be of indirect significance to the organization. For example, there may be religious concerns with Muslim American soldiers that are deployed to the Middle East. The commander may need to be aware of this, and also may need to delegate direct management to a staff member. Personal staff members manage issues of this nature in Garrison and in operational AoR for the commander. The command's Chaplain is one example. There are other examples, which are not mentioned here because they are not directly part of the mission planning process.

4.   COORDINATING STAFF
a.   *Executive Officer-Chief of Staff*

The Executive Officer is the commander's principal assistant for directing, coordinating, supervising, and training the staff, except in areas the commander reserves. The commander normally delegates executive management authority (equivalent to command of the staff) to the XO. The XO frees the commander from routine details and passes pertinent data, information,

and insight from the staff to the commander and from the commander to the staff. The XO is responsible for:

- Integrating and synchronizing the war-fighting plans
- Managing the commander's critical information requirements
- Establishing, managing, and enforcing the staff planning time-line in accordance with the commander's guidance
- Supervising the targeting, deep operations, and other cross-forward line of troops planning cells
- Integrating deception planning and fratricide countermeasures into the plan
- Determining liaison requirements, establishing liaison information exchange requirements, and receiving liaison teams
- Directly supervising the main command post and headquarters cell, including displacement, protection, security, and communications
- Directing and supervising the staff's planning process
- Ensuring all staff members provide intelligence preparation of the battlefield (IPB) input to the G2.
- Maintaining knowledge of all directives, orders, and instructions the commander issues to the staff, subordinate commanders, and subordinate units, and verifying their execution

b. *S1-Personnel*

The S1 is the principal staff officer for all matters concerning human resources (military and civilian), which include personnel readiness, personnel services, and headquarters management. A personnel officer is located at every echelon from battalion through corps. Following are some of the areas and activities that are the specific responsibility of the S1.

- Analyzing personnel strength data to determine current combat capabilities

- Development of plans to maintain strength

- Personnel replacement management, which includes: receiving, accounting, processing, and delivering personnel

- Advising the commander and staff on matters concerning individual replacements and the operation of the replacement system

- Preparing estimates for personnel replacement requirements based on estimated casualties, non-battle losses, and foreseeable administrative losses

- Integrating the personnel replacement plan from the S1 with the equipment replacement plan from the S4 and with the training plan from the S3

- Coordinating and monitoring readiness processing, movement support, and the positioning of replacement-processing units

c.   *S2-Intelligence*

The S2 is the principal staff officer for all matters concerning military intelligence (MI), counterintelligence, security operations, and military intelligence training. An intelligence officer is located at every echelon from battalion through corps. Following are the areas and activities that are some of specific responsibilities of the S2:

- Disseminating intelligence to commanders and other users in a timely manner

- Collecting, processing, producing, and disseminating intelligence information

- Conducting and coordinating intelligence preparation of the battlefield (IPB)

- Recommending unit area of interest and assisting the staff in defining unit battlespace

- Evaluating the threat (their doctrine, order of battle factors, high-value targets (HVTs), capabilities, and weaknesses)

- Determining enemy most probable and most dangerous courses of action and key events

- Coordinating with the entire staff and recommending PIR for the commander's critical information requirements

- Integrating staff input to IPB products for staff planning, decision making, and targeting

- Coordinating ground and aerial reconnaissance and surveillance operations with other collection assets

- Participating in targeting meeting

d. *S3-Operations*

The S3 is the principal staff officer for all matters concerning training, operations and plans, and force development and modernization. An operations officer is located at every echelon from battalion through corps. The areas and activities that are the specific responsibility of the G3 (S3) follow:

- Participating in targeting meetings

- Reviewing plans and orders of subordinate units

- Synchronizing tactical operations with all staff sections

- Reviewing entire operations order for synchronization and completeness

- Coordinating with the S2 to write the reconnaissance and surveillance annex, which includes tasking units with available assets, to collect the commander's priority intelligence requirements

- Recommending Intelligence Requirements to the S2.

- Integrating fire support into all operations

- Planning troop movement, including route selection, priority of movement, timing, providing of security, bivouacking, quartering, staging, and preparing of movement order

- Determining combat service support (CSS) resource requirements in coordination with the G1 and G4
- Participating in course of action and decision support template (DST) development with S2 and FSCOORD
- Coordinating with ENCOORD, S2, S5, and surgeon to establish environmental vulnerability protection levels
- Recommending the general locations of command posts
- Coordinating with the S1 civilian personnel involvement in tactical operations

e.   *S4-Logistics Supply Management*

At brigade and battalion levels, the S4 not only coordinates activities but also executes requirements for the commander and unit. The areas and activities that are the specific planning and preparation responsibilities of the S4 are as follow:

- Providing information on enemy logistics operations to the S2 for inclusion to IPB
- Developing with the S3 the logistics plan to support operations
- Coordinating with the S3 and S1 on equipping replacement
- Coordinating with supporting unit commander on the current and future support capability of that unit
- Coordinating the selection and recommending of main supply routes (MSR) and logistics support areas, in coordination with the ENCOORD, to the S3.
- Coordinating the requisition, acquisition, and storage of supplies and equipment, and the maintenance of Materiel records.
- Ensuring, in coordination with the Provost Marshall, that accountability and security of supplies and equipment are adequate.

- Calculating and recommending to the S3 basic and prescribed loads and assisting the S3 in determining the required supply rates.
- Coordinating and monitoring the collection and distribution of excess, surplus, and salvage supplies and equipment.
- Directing the disposal of captured enemy supplies and equipment after coordination with the S2.
- Coordinating the allocation of petroleum products to subordinate units.
- Coordinating with the S5 to support foreign nation and host nation support requirements.

f.   *S5-Civil-Military Affairs*

The S5 is the principal staff officer for all matters concerning civil-military operations (the civilian impact on military operations and the impact of military operations on the civilian populace). The S5 has responsibility to enhance the relationship between military forces and civilian authorities and personnel in the area of operations to ensure the success of the mission. The S5 is required at all echelons from battalion through corps level but authorized only at division and corps levels. Once deployed, units and task forces below division level may be authorized an S5. The areas and activities that are the specific responsibility of the S5 follow:

- Advising the commander of the civilian impact on military operations.
- Advising the commander on his legal and moral obligations concerning the impact of military operations on the local populace (economic, environmental, and health) for both the short and long term
- Minimizing civilian interference with combat operations, to include dislocated civilian operations, curfews, and movement restrictions
- Advising the commander on the employment of other military units that can perform CMO missions

- Establishing and operating a civil-military operations center (CMOC) to maintain liaison with and coordinate the operations of other US government agencies; host nation civil and military authorities; and nongovernmental, private voluntary, and international organizations in the area of operations

- Planning positive and continuous community relations programs to gain and maintain public understanding and good will, and to support military operations

- Coordinating with the Staff Judge Advocate (SJA) concerning advice to the commander on rules of engagement for dealing with civilians in the area of operations

- Providing recommended Civil-Military Officer (CMO)-related information requirements and Essential Elements Of Friendly Information (EEFI) to the G2

- Providing the S2 operational information gained from civilians in the area of operations

- Coordinating with the S3 PSYOP on trends in public opinion

- Coordinating with the S1 surgeon on the military use of civilian medical facilities, materials, and supplies

g. *S6-SIGO*

The S6 is the principal staff officer for all matters concerning signal operations, automation management, network management, and information security. A S6 officer is located at all echelons of command from battalion through corps. The areas and activities that are the specific responsibility of the S6 follows:

- Recommending signal support priorities for force information operations

- Recommending locations for command posts within information battlespace

- Coordinating with the S5 the availability of commercial information systems and services for military use

- Coordinating, updating, and disseminating the command frequencies lists.

- Managing communications protocols, and coordinating user interfaces of defense information system networks (DISNs) and command and control systems down to battalion tactical internets

- Recommending information requirements to the S2

- Participating in targeting meetings

- Coordinating the configuration of local area networks that support the force

- Managing communications security (COMSEC) measures, including the operation of the Information

- The command's signal support network

5. **SPECIAL STAFF**

    a. ***Chemo-Chemical Officer***

    The chemical officer is the special staff officer responsible for the use of or requirement for chemical assets and Nuclear-Biological-Chemical (NBC) defense and smoke operations. A chemical officer is at every echelon of command. Besides his common staff responsibilities, the chemical officer's specific responsibilities are as follows:

- Recommends Courses of Action (COA) to minimize friendly and civilian vulnerability

- Provides technical advice and recommendations on mission-oriented protective posture (MOPP), troop safety criteria, operational exposure guidance, NBC reconnaissance, smoke operations, biological warfare defense measures, and mitigating techniques

- Assesses probability and impact of NBC-related casualties

- Coordinates across the entire staff while assessing the impact of enemy NBC-related attacks and hazards on current and future operations

- Conducts NBC IPB vulnerability analysis and recommends information requirements to the G2 through the G3

- Plans, supervises, and coordinates NBC decontamination (except patient decontamination) operations

- Supervises the nuclear and chemical accident and incident response assistance program

- Assesses weather and terrain data to determine if environmental factors are conducive to enemy employment of Weapons of Mass Destruction (WMD) or, at corps level, to the friendly employment of nuclear weapons

- Plans, coordinates, and manages chemical and radiological survey and monitoring operations

- Plans, coordinates, and manages NBC reconnaissance operations

- Estimates effect of a unit's radiation exposure state on mission assignments

- Coordinates with the S4 on logistics as it relates to chemical defense equipment and supplies, maintenance of chemical equipment, and transportation of chemical assets

- Coordinates NBC reconnaissance assets into the reconnaissance and surveillance plan

- Plans and recommends integration of smoke and obscurants into tactical operations

- Conducts smoke target development

- Advises the commander, in conjunction with the surgeon, on possible hazards and effects of low-level hazards, such as low-level radiation and toxic industrial material

- Advises the commander, in conjunction with the ADCOORD, on passive defense measures to assist in protecting and warning the force against missile attack

- Advises the commander on the use of riot control agents

b. *FSO-Fire Support Officer*

The fire support coordinator is the special staff officer for coordinating fire support and field artillery assets and operations in the command. The Fire Support Officer is the senior field artillery officer in the force. He is the commander of a field artillery unit supporting the force. The assistant or deputy Fire Support Officer is a permanent staff officer on the staff representing the Fire Support Officer in his absence. There is a Fire Support Officer with the maneuver force at every echelon of command from battalion through corps. At brigade, regiment, and below, the Fire Support Officer's specific responsibilities are as follows:

- Develops, with the S3, a concept of fires to support the operation
- Plans and coordinates fire support tasks for supporting forces in contact
- Plans and coordinates fire support tasks for supporting the commander's battle plan
- Plans and coordinates fire support tasks for synchronizing the fire support system
- Plans and coordinates fire support tasks for sustaining the fire support system
- Plans and coordinates fire support tasks for integrating non-lethal fires into the overall scheme of fires
- Participates in the targeting meeting and produces targeting products, such as target selection standards (TSS), and high-payoff target list (HPTL)
- Plans and coordinates, through the G3 (S3), with the G2 (S2), signal officer, and EWO, the use of electronic warfare support and electronic protection as part of fire support
- Recommends information requirements to the G2 through the G3
- Plans and coordinates with the ENCOORD for the use of air- and artillery-delivered FASCAM

- Recommends to the G3 (S3) the field artillery ammunition required supply rate
- Provides an estimate of the adequacy of the field artillery ammunition controlled supply rate
- Recommends internal reallocation of the controlled supply rate for subordinate commands to match priorities for support
- Establishes priorities and focus for counter-fire radar employment
- Recommends field artillery organization for combat
- Coordinates positioning of fire support assets in specific area of operations
- Coordinates and synchronizes joint fire support platforms

c. *ENCOORD-Engineer Coordinator*

The engineer coordinator (ENCOORD) is the special staff officer for coordinating engineer assets and operations for the command. The ENCOORD is usually the senior engineer officer in the force. He is the commander of an engineer unit supporting the command. The assistant or deputy ENCOORD is a permanent staff officer representing the ENCOORD in his absence. An ENCOORD is located at corps and division levels and one is normally task-organized to maneuver brigades and battalions. Besides his common staff responsibilities, the ENCOORD's specific mission planning responsibilities are as follows:

- Mobility, Counter-mobility (CM), Survivability
- Recommends engineer organization for combat
- Plans and coordinates with the S3 -Fire Support Officer on the integration of obstacles and fires
- Advises the commander on the use of organic and non-organic engineer assets
- Advises the commander on the employment and reduction of obstacles

- Advises the commander on environmental issues, coordinates with other staff officers to determine the impact of operations on the environment, and helps the commander integrate environmental considerations into the decision-making process

- Provides a terrain-visualization mission folder to determine the terrain's effect on both friendly and enemy operations

- Produces maps and terrain products (coordinates with the G2 for planning and distribution)

- Plans and supervises construction, maintenance, and repair of camps and facilities for friendly forces, enemy prisoners of war, and civilian internees

- Plans and coordinates with the FSCOORD the use of family of scatterable mines (FASCAM)

- Plans and coordinates environmental protection, critical areas, and protection levels

- Assists the S2 in IPB preparation, to include preparing the engineer battlefield assessment (EBA)

- Participates in the targeting meeting.

- Provides information on the status of engineer assets on hand.

- Recommends to the S4 main supply routes and logistics areas based on technical information

- Recommends information requirements to the S2 through the S3

- Plans the reorganization of engineers to fight as infantry combat units when the commander deems their emergency employment necessary.

d.   *ALO- Air Liaison Officer*

The air liaison officer is the special staff officer responsible for coordinating tactical air assets and operations such as close air support (CAS), air interdiction, joint suppression of enemy air defense (SEAD), reconnaissance, and airlift. The ALO is the senior Air Force officer with each tactical air control

party (TACP). An ALO is authorized at corps, division, and brigade levels. The ALO's specific planning responsibilities are as follows:

- Advises the commander and staff on the employment of tactical air (TACAIR).
- Coordinates tactical air support missions with the fire support element and the appropriate AC2 element.
- Recommends information requirements to the S2 through the S3
- Participates in targeting meetings

B.   SUMMARY

As is illustrated, each member of the coordinating and special staff must perform a number of planning and coordination tasks prior to executing a combat mission, which under the current convention means a tremendous amount of meetings, coordination, and information distribution. The primary means of communicating tasks is through face-to-face coordination meetings and distribution of increasingly large documents that we will eventually identify as message blocks.

The flow of message traffic is complex and unpredictable. Units have tried, in the past, to log documents of the message distributions and message update distributions. This turned out to be cumbersome to the extent that keeping track of who received which version of which documents, and who did not, became more difficult than actually writing the documents. Message distribution and management can be modified using automation and a modified message distribution scheme. If information can be distributed more efficiently, then it should follow that planning and preparation can also be done more efficiently.

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IV.   THE MILITARY DECISION MAKING PROCESS

A.   MDMP OVERVIEW

The Military Decision Making Process (MDMP) is the current definitive process combat commanders and staffs at battalion and above operating levels of the U.S. Army use to develop mission plans. The MDMP process is similar to the problem solving process with a more focused detail given to the factors that affect the tactical/operational environment. The MDMP requires the support and participation of the coordinating and special staff members in order to be successfully implemented in any combat environment. If any of the staff functions fail then the process is incomplete: increasing the risk of implementing a plan without all of the information. Different decisions might be made with additional information.

There exist a number of written products that are developed directly from MDMP process and this thesis is focused on modifying the products. Because of the limited number of formal products that are generated, their importance is paramount to the success of the combat mission. Complete, timely and clear are the prime measures of how effective the product was in causing units to execute combat tasks efficiently and as expected.

Below is a summary of the process steps of a mission analysis process, as taken from FM 100-5 Operations, 1993. It describes what should take place, as well as who should be involved in the process. The products are addressed by who does them and what they contribute.

1.   Receive Mission

The decision-making process begins with the receipt or anticipation of a new mission. This can either come from an order issued by higher headquarters, or derived from an ongoing operation. For example, the commander determines that he has the opportunity to accomplish his higher commander's intent significantly different from the original course of action because of a change in

enemy disposition. This may cause him to plan for a significantly different course of action.

As soon as a new mission is received, the unit's S3 operations section issues a warning order to the staff alerting them of the pending planning process. Unit standard operating procedures (SOP) identify who is to attend, who the alternates are, and where they should assemble. The XO generally ensures that attached units have copies of the unit SOP to ensure they will understand what is expected of them during the orders process.

2. Analyze Mission

Mission analysis is a comprehensive process that follows the receipt of a mission from the higher echelon. It is designed to parse information received from higher echelon headquarters and extract any specified or implied tasks that the order dictates. To facilitate the necessary movement and preparation of subordinate personnel and equipment, mission analysis is conducted as early as possible.

The coordinating and special staff personnel are expected to respond to the warning order by taking preparatory actions and issuing warning orders to their subordinate members. During or immediately following the warning order issue, the staff members are expected to participate in the course of action development process in addition to planning their own operations to support the commander's intent.

After conducting the initial mission analysis, each staff section should be able to extract explicit tasks expected of them. Critical and implied tasks are identified to support the specified tasks. For example, if a maneuver unit is expected to move from one point to another using the most direct route, and a river bisects this route, then the implied task may be to conduct a river crossing operation in the process of accomplishing the specified task. This is important, particularly for heavy combat units, containing tanks, infantry carriers and mechanized artillery. A river crossing is an extremely significant event, however,

it is not the mission itself and may not affect other sub-units and it may not be spelled out in the higher unit mission plan.

Therefore, it is important for the unit conducting this operation to receive this specified task as early as possible in order to make the necessary preparations and movements for the mission and the river crossing operation nested within it. Additional detail may be required in a second warning order to give the sub-unit enough time to prepare for the mission.

3.   Course of Action Development

After receiving guidance, the staff develops several courses of action for analysis and comparison. The commander must involve the entire staff in the development. His guidance and intent focus the staff's creativity to produce a comprehensive, flexible plan within the time constraints. His direct participation helps the staff get responsive, accurate answers to questions that occur during the process.

4.   Course of Action Analysis

The course of action analysis identifies which course of action accomplishes the mission with minimum casualties while best positioning the force to retain the initiative for future operations. It helps the commander and the staff to determine how to maximize combat power against the enemy while protecting the friendly forces and minimizing collateral damage. No written product should be distributed at this time, since no decisions have been made as to who will be executing anything.

5.   Course of Action Comparison

The course of action comparison starts with each staff officer analyzing and evaluating the advantages and disadvantages of each course from his perspective. Each staff member presents his findings for the others consideration. Using the evaluation criteria developed earlier, the staff then

outlines each course, highlighting its advantages and disadvantages. Comparing the strengths and weaknesses of each course of action helps identify their advantages and disadvantages with respect to each other. The staff compares courses of action to identify the one that has the highest probability of success against the most likely and the most dangerous enemy courses of action.

6.   Course of Action Approval

If the commander has observed and participated in the planning process, the course of action decision may be rapidly apparent and the commander can make an immediate decision. If he has not participated in the process to this point, or has not made a decision, a decision briefing will still be required. Good course of action comparison charts and sketches assist the commander in visualizing and distinguishing between each course. If only one course was developed, no decision is required, unless this course becomes unsuitable, infeasible, or unacceptable. If this occurs, another course of action must be developed.

As appropriate, the core of the impending operations order is the course of action approved by the commander. Immediately following the course of action development process, a third, detailed warning order is generated and distributed to the sub-units. This warning order is very detailed, however, the majority of the mission information should already be available to subordinate units due to the accumulation of warning orders. Subsequently, the units should be almost prepared to execute to mission by the time they receive the formal order.

7.   Orders Production

The actual operations order is the formalization of all of the process steps and previous warnings about the upcoming mission. If the process was executed correctly, most of the information in the order should come as no surprise to the units receiving them. The order itself should not be needed except as a reference for clarification of some specific details. If sub-unit commanders and soldiers find

themselves constantly referring to the order for clarification, then the process needs to be reviewed. The generations order considered the final product of the mission development process. Any written document following its distribution is considered an amendment to the operations order.

NOTE 1: Commander may conduct phases independently or in conjunction with staff.

NOTE 2: Staff coordination is continual up and down.

RECEIPT OF MISSION
♦ Issue cdr's initial guidance

WARNING ORDER

MISSION ANALYSIS
♦ Approve restated mission
♦ State commander's intent
♦ Issue cdr's guidance
♦ Approve CCIR

WARNING ORDER

Commander's Estimate
(continual process)

COA DEVELOPMENT

COA ANALYSIS
(War Game)

Staff Estimates
(continual process)

COA COMPARISON

COA APPROVAL
♦ Approve COA
♦ Refine commander's intent
♦ Specify type of rehearsal
♦ Specify type of order

WARNING ORDER

ORDERS PRODUCTION
♦ Approve order

♦ Commander's Responsibility

REHEARSAL

NOTE 3: For a discussion of rehearsals, execution, and assessment, see Chapter 6 and Appendix G.

EXECUTION & ASSESSMENT

NOTE 4: At any time during execution and assessment, situation may require the process to start again.

Figure 2: Mission planning and development process illustration

B.   MISSION PRODUCTS

As will be echoed throughout the remaining chapters, the earlier in the mission development process units receive clearly specified tasks, the greater their ability to prepare. The most valuable resource to units in preparation for a mission is time. The more preparation time the greater the chances of success in execution. In contrast, wasting time, works against these odds.

a.   *Warning Orders*

Warning orders serve as the indicator to begin the mission development cycle and troop leading procedures discussed below. As the number of warning orders increase, the greater the amount of detail they contain. Intuitively, it is an indication of an approaching execution time, sometimes referred to as T-time. The following is a short non-exclusive list of what the minimum expectations in a warning order is:

- Required maps
- The enemy situation and significant intelligence events
- The higher headquarters' mission
- Mission or tasks of the issuing headquarters
- The commander's intent statement (when available)
- Orders for preliminary action, including reconnaissance and surveillance
- Coordinating instructions (estimated time lines, orders group meeting, time to issue order)
- Service support instructions, any special equipment necessary, regrouping of transport, or preliminary movement of units

Any line of information that specifies or implies action is of benefit to the receiving sub-unit; the sub-units utilization of time increases as the details of the mission tasks increase.

2.   Operations Orders

As stated earlier, if the mission development process of the higher headquarters units is well executed, the tasks in the operations order should come as no surprise to the recipients. There should be only minor adjustments left to make by the time the order is finalized and distributed. The operations order is a more detailed and formal document than a warning order and is discussed in more detail below.

a. *Situation*

The situation paragraph outlines the environment the mission is to be executed in. In short, it defines the tactical and operational problem. It also links the units together as task organized components of the immediate higher unit leadership. It describes the terrain and expected weather conditions when the operation will be executed. It lists the expected enemy forces and the organized friendly units that will meet on the battlefield.

Arguably the most important information components in the situation paragraph are the mission statements and commander's intent of the next two or three higher echelons of command. This gives the reader a quick reference to how the higher echelons of command see the collective forces accomplishing the task and also acts as a guideline for making tactical judgment calls during the execution of the mission.

Every soldier within a unit should be able to reference commander's intent statements two to three levels of command above them. There are generally no explicit tasks specified in this paragraph. It is used for reference and battlefield visualization only. As a component of the operations order, the majority of the information in the situation paragraph is information either known well in advance, slow to change from mission to mission or both. This point is emphasized in more detail later.

b. *Mission Statement*

The mission statement is a succinct set of sentences that state definitively what the mission is, as seen by the issuing commander. It contains one to three statements of execution as follows: mission, on-order mission and be prepared mission. The elements of the mission statement are: who, what, when where why, task and purpose. The on-order mission statement has the same elements as the mission statement with the exception that the 'when' element is replaced with 'on-order'. The 'be-prepared' mission statement is essentially the same as the mission statement with the added label. 'Be

prepared' missions have the lowest priority of preparation because they may or may not be executed.

Generally, units use SOPs for specific types of missions. Based on the 'what' element of the mission statement, units can refer to their SOP manual for what planning and preparation tasks are implied by the specific mission and execution task list.

c. *Execution*

The execution paragraph is the most complex component of the operations order because it defines how we are going to solve the problem defined in the situation paragraph. In essence, it contains the vast majority of specified and implied tasks of the entire order. Most of the instructions for how an operation is to be conducted and, equally as important, why it is to be conducted are contained within the execution paragraph. The tone of the paragraph is similar to a cause and effect linkage of execution tasks though the format is generally narratives and lists. Therefore the art and science of leadership is to determine from the order, the cause and effect linkages, as well as the chronology and the critical essence of the tasks within the statement. This is where the scope of this study's analysis will take shape.

The following topics are entries into the execution paragraph of a combat operations order as recommended by the (TRADOC) and are echoed in most field manuals as the de facto standard by which the effectiveness of an operations order is measured.

d. *Commander's Intent*

The commander's intent is the vision statement or end-state statement of a given combat mission. It is usually narrative in nature and because of this, there have been years of debate as to how long the intent statement should be and what it should contain. This statement serves more to circumscribe the actions of the units under the responsibility of that commander,

for situations where there are no specified or implied tasks. It allows soldiers in combat to make judgment calls of what they think the commander would have told them to do in a given situation had he been able to anticipate every situation and capture it in writing. Hence, the enormous amount of debate as to what should go into it.

Most military scholars argue that it should be succinct and should reflect the commander's personality and style. It should also be consistent from mission to mission. As soldiers begin to understand their commander's style and personality, their ability to represent the commander's intent in any situation improves.

Though not as vital as the next few components for this study, some military scholars have argued that the set of commander's intent statements (within the chain of command, two to three levels up) are the most important statements in the entire order because most military mishaps occur because of poor judgments made within the gray areas of what the commander says and want the commander actually desires.

e. *Concept of the Operation*

The concept of operation is a component of components paragraph that can be expressed in many different ways. Below is a sample concept of operation matrix that shows the contents of specified tasks given to sub-units within a specific combat organization. The target level of this matrix is the brigade, as the issuing command, and the battalion, as the receiving command.

f. *Tasks to maneuver units*

The tasks to maneuver units are specified tasks directed to specified units. They are often general in nature. Their format is usually identical to mission statements, on-order mission statements and be prepared mission statements. The key difference is that these tasks are listed for every identifiable maneuver sub-unit within the issuing unit's command.

g. *Tasks to combat support units*

The tasks to combat support units are also specified tasks directed to specified units. They too are general in nature but often very different in format than those for maneuver units. The format is expected to be consistent with the types of information the specific types of supported units need. For instance a fire support unit needs very different information than that of an engineer unit. Often times engineer units execute their missions prior to the start of combat. Fire support units, on the other hand, share execution resources between reconnaissance and surveillance, counter-fire support and maneuver execution missions. The key point here is that the anatomy of a task message can be generalized as message components the same way that maneuver tasks can be.

h. *Coordinating Instructions*

Coordinating instructions are explicit planning and preparation tasks that should be performed between two or more sub-units within the command. These tasks are often decipherable implied tasks however, the more critical the success, the more likely the coordination task is specified in this paragraph.

i. *Service Support*

Logistics support is a critical aspect of any combat mission. The support tasks that are explicitly stated can generate implicit tasks in order to accomplish them. Both explicit and implicit tasks are specific to the types of support units involved. The support can include medical, fuel, ammunition, water, engineering materiel movement; troop movement by land or by air transport and so on.

j.   *Command and Signal*

The command and control paragraph generally contains the chain of command location, signal instructions, radio frequency of units, the commander and specific staff frequencies. Generally, there are no tasks issued in this paragraph. It should also be mentioned that most of the information in this paragraph should be determined well in advance; capable of being stored well in advance of the MDMP process.

3.   Fragmented Orders

Fragmented orders are an extension of operations orders. By referencing an existing order and listing only the information that has changed from the referenced order, fragmented orders can save units time and resources.

Units will usually use fragmented orders after an operations order is written, issued and in the process of being executed. The components of a fragmented order are the same as the components of an operations order with the paragraphs that did not change omitted.

4.   TROOP LEADING PROCESS

Troop leading procedures are an abbreviated planning process that company-level units and below use to determine what the planning, preparation and execution tasks are required. Companies and platoons do not have planning staffs. The commanders at these levels write their own orders based on the orders received from the higher-level units.

However, because these units are expected to execute the plan, they have the least amount of time to determine what is required. This is considered a terminal-level unit. In other words, all of the staff planning is intended to set success conditions for the lower-level units, executing the tasks.

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V.   MISSION TASK DISTRIBUTION

A.   DISTRIBUTION OF TASKS OVER TIME

The importance of lead-time in mission planning has given impetus to combat leaders to make early distribution of information a high priority. However the U.S. Army has limitations on its ability to disseminate formalized mission products as quickly as the commander perceives is possible. Because the U.S. Army constrains its efficiency of distributing time-critical information to the distribution efficiency of the formal mission products, the unit staffs introduce poor utilization of a fixed time quantum into its unit preparation processes by default.

It has been shown in network communications that packet switching can be much more efficient than message switching. The reason is because the delay associated with processing and transmitting an entire message across a link can be more costly than the overhead associated with labeling several smaller packets and transmitting them independently. Intermediate processing and routing nodes have to receive and possibly queue entire messages before processing and re-transmitting them. Whereas with parts of a message being sent independently, the intermediate nodes can process and retransmit one part of a message while receiving another part of the message, that is, the terminal node will begin receiving parts of the entire message sooner than with message switching.

If this logic is applied to mission-analysis products and parts of warning orders or operations orders are sent as soon as one has the minimum requirements for a message part, then the terminal-level units should receive useful information sooner and can respond to it by planning and preparing sooner.

To further describe this, assume that in a given tactical environment, we generalize the amount of time it takes to prepare to execute one specified task as four hours. The amount of planning and preparation time from the first-warning order, from a theater-level command, issued is ninety-six hours. Each cell

processes the received warning order and issues their own warning order to the next command and staff group. Consider a command and staff group as an enclosed, communications processing node and the warning order communication to the sub-unit staff as a link-level communication. Assume that a brigade node receives a warning order, begins processing, and retransmits a complete warning order to another sub-unit two hours later. This process repeats itself from intermediate node to intermediate node until it reaches its terminal point at the platoon level. By the time a platoon receives its first Warning order, eight to twelve hours have passed. This time cannot be recovered and the preparation for the mission still has to be completed.

What if the message was filtered to send the most time-critical information first and the rest later on? In other words, the specified tasks are what the platoons and companies need to know immediately. If they can receive these tasks earlier, they gain the preparation time that they will know how to use. Therefore, by deconstructing the message format and prioritizing what needs to be sent, there is a potential gain in preparation time that can grow as the message traverses the staff planning nodes.

B.   ORDERS PROCESS REDEFINED

The MDMP process has become the cornerstone of conventional combat planning and preparation for the U.S. Army for the past fifteen years. It has evolved from use in training and combat to be a trusted tool for setting the conditions for successful execution of combat missions. The process is efficient and most staff officers that use it would likely say that it is comprehensive, possibly even excessive in its level of detail.

The major drawback of the MDMP is that it does not address certain types of execution shortcomings. Once again, one of the most important resource in mission planning and preparation is time for sub-units to respond to orders by conducting the same process as the issuing command and staff on a shorter time scale. As a rule of thumb, each level of command and staff is supposed to yield two thirds of its planning and preparation time to it subordinate units. In practice, though, this is rare. This is due, in part, to the orders processing delay that the

issuing staff incurs on receiving the orders themselves. The inability to yield planning and preparation time is also due to the fact that execution times are fixed and dictated at very high echelons of command. Hence, the use of the current process will always result in some level of delay. Therefore when the lowest units (maneuver platoons and reconnaissance squads) receive mission tasks, the mission clock has long since started.

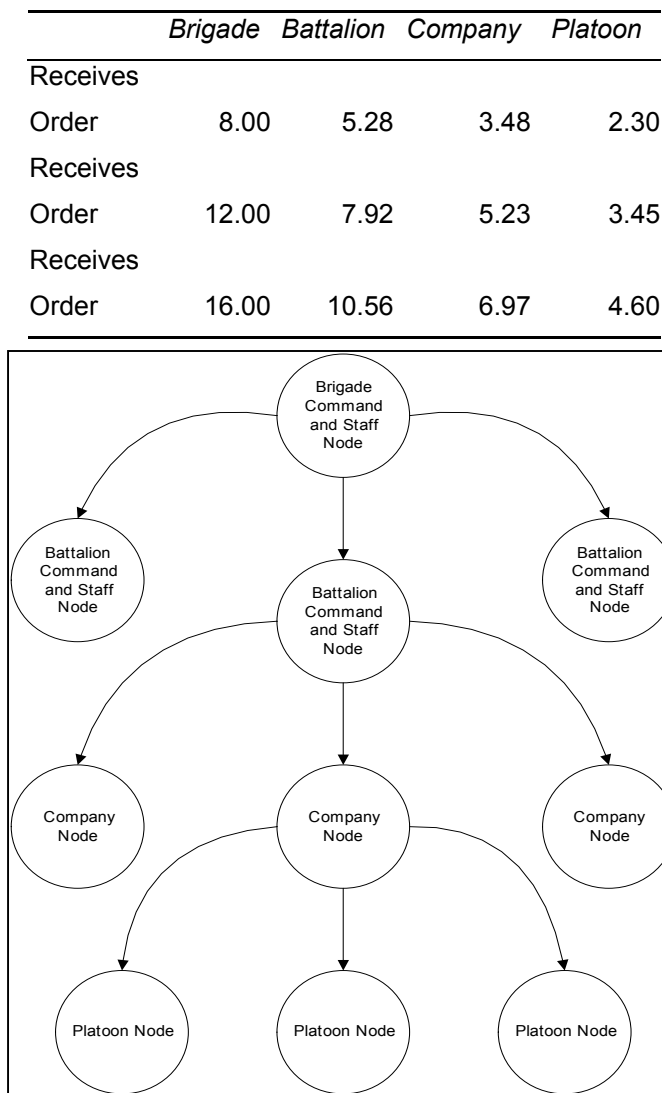|	*Brigade*	*Battalion*	*Company*	*Platoon*
Receives Order	8.00	5.28	3.48	2.30
Receives Order	12.00	7.92	5.23	3.45
Receives Order	16.00	10.56	6.97	4.60

Figure 3: Message distribution illustration based on 8, 12 and 16 hour planning windows.

What Figure 3 shows is the effects of yielding two-thirds of planning time to sub-units. The more time the higher unit retains, the greater the time impact is to the sub-unit. It is incumbent on high echelon commands to push information to sub-unit commands as soon as possible. The sense of urgency sometimes has to be artificially created in order to enforce this as an issue of command policy. High-level staffs need to be mindful that the more time they take to process missions orders and distribute them, the less likely the combats units will be prepared to execute those missions.

For comparative purposes, in electronic network communications, the largest delay a communications packet will incur is the queue delay at a high-traffic router while waiting to be transmitted on a transmission link. Relative to the total transmission time queuing time accounts for about two-thirds of transmission time on a network from source to destination. In a mission-plan distribution, the source of the mission order is a high-level command and staff cell.

The ultimate destination, though greatly parsed and modified, is the tactical-level unit at the lowest levels of command. In computer networking, queuing delay analysis is one of the most important study factors in communicating data. Thus, it should follow, in mission planning, that if the lowest level units need information as soon as possible to have time to prepare for upcoming missions, then the mission analysis process conducted at an intermediate cell is analogous to the delay incurred on a network router. Therefore, reducing the delay of mission distribution to subsequent units is an important factor in improving the efficiency and effectiveness of the MDMP process.

C.   MESSAGE CONCEPTS

1.   Message switching

Message switching is a networking concept in which entire messages are sent from a source point to a destination point through a series of intermediate

routing points to an edge routing node. As was later discovered, the high error probability and the quantity of time it took to transmit an entire message block from link to link caused poor utilization of a resource that eventually would be in high demand. The key shortcoming, as illustrated, is that the entire message has to be transmitted and checked for errors and completeness before it can be queued for forwarding to the next node.

2.   Packet switching

Packet switching is based on optimizing a network's communication process by deconstructing a message into smaller, more manageable parts and transmitting each one separately on network links. Gains in efficiency are achieved by being able to receive a small packet, process it, and transmit another at the same time. For a given fixed message size, if the processing, queuing and transmission of message on a link takes fifteen seconds, then by breaking the message into five equal sections and transmitting each one separately, should take approximately one fifth the time.

The packets leapfrog the network nodes in a staggered manner, (see Figure 3) until the last packet reaches the terminal node. The parameters are as follows:

P_n = Number of Packets

P_{nd} = Packet Nodal Delay = M_{nd}/P_n

N_n = Node Count

M_{nd} = Message Nodal Delay

M_d = Total Message Delay = $M_{nd} * N_n$

P_d = Total Packet Switching Delay = $(P_n + (P_n - 1)) * P_{nd})$

Figure 4: Packet switching calculation illustration

D. INFORMATION SHARING

1. Information Pushing

Information pushing is the source-initiated flow of information by planning staffs to lower units in the chain of command structure. It means that the lower units do not have to demand information and wait for communications response from the serving staff. More generally, it is a producer-consumer relationship in which the producer supply-cycle is shorter than the consumer demand cycle. The significance is that if the higher serving staff has information the lower staff or maneuver units need before the lower units asks for it then the lower level unit does not have to wait for the producer to produce the information; ultimately this means the lower-level unit does not have to wait on the higher-level units. Lower level command and staff groups can be well ahead of their higher level counterparts in obtaining information about upcoming missions.

2. Information Pulling

Information pulling is the opposite of information pushing. In mission planning activity, it is the lower-level C&S unit querying the higher-level unit for information concerning the upcoming mission. More generally, it is a producer-consumer relationship where the consumer demand is greater than the producer can supply information. This is more often the situation in mission planning.

This behavior pattern in the producer-consumer relationship is expected and in fact should be the optimal relationship between higher and lower units. It means that the lower units are not overwhelmed and can process more information and perform more tasks. The measure of effectiveness is found in the amount of time the lower-level units wait, on average, for their information demands to be filled. In theory, the shorter the average wait, the better the potential performance conditions of the lower and intermediate-level unit in processing the information and fulfilling requests.

3.   Information Filtering

In recent years, the U.S. Army, like its civilian sector counterpart, has begun to address a phenomenon that was not an operational concern just fifteen years ago. Units now have to contend with the possibility of receiving too much information too quickly.

Some commanders in training exercises had reported that their staffs had trouble giving them useful information to make timely decisions because they simply had too much information to process. There was no process in place to deal with this because some of the information yielded had never been seen before. Commanders and their staffs found it difficult to categorize and process information that they had not expected to receive.

Commanders also found that there were no operational processes in place for quickly porting that information to the units they wanted to get the information to. Now, command and staff units are challenged with managing all of the sources of information, trying to make it operationally meaningful and leveraging it to gain a tactical or operational advantage.

In electronic network communications, switching and routing technology facilitates the movement away from broadcast communications to managed distribution using switch-based equipment, thus reducing the footprint of the message as it traverses a dynamic network from source to destination. In order to manage resources effectively on a network, there needs to be a mechanism in place to determine the destination of the message. The hardware and software that facilitate delivery of the message needs to be intelligent enough to customize routing behavior to deliver the message in a more efficient manner than broadcasting to every end-node that is downstream from an edge router associated with the intended destination node. This also means that the message has to contain enough information about its distribution to ensure its delivery.

E. MISSION PRODUCTS AS MESSAGES

The same customization goal of network routing behavior can be extended to mission planning products that may be communicated on an electronic network. Using this analogy, small messages intended to be multicast to a small number of end users do not need to be broadcast to large numbers of users who have to allocate human resources toward determining that the message was not intended for or useful to them in the first place.

Currently the prioritization of messages or parts of messages is the responsibility of the receiving command and staff unit to determine. There are parts of every mission order type that are not as important as other parts. This is not to say that the parts that are not as important do not need to be communicated prior to the mission execution. However, with time being one of the most important resources, if the message part does not affect the preparation actions of the receiving unit then communicating it ahead of a message part that does is inefficient and distracts the unit, even if for a small amount of time, from moving and preparing for the mission.

1. Task Packets

The concept of task packets centers on deconstructing messages to extract parts or components of a message that meet specific criteria. The test for determining which components need to be extracted is based on the effect it will have on the unit that receives it. If the receipt of the message component causes the unit to take some action and the action requires significant resource usage (such as time) then the component is a time-sensitive, task-oriented component. It should be sent as a high-priority, stand-alone message instead of waiting for other message parts to be processed.

F. CLASSIFYING TASK TYPES

'Specified Tasks' is an explicit category header of information that is usually included in Warning orders, Operations orders and Fragos. It details

specific operational tasks that are dictated to lower level units from higher-level units. Specified tasks require the receiving sub-unit to take planning and preparation action. These tasks are easily identifiable because they are under the header of mission statement, specified tasks and concept of the operation.

'Implied Tasks', as their name indicates, are more difficult to identify. These tasks are equally as important as specified tasks as they can require significant planning and preparation action takes place. Therefore these tasks also have time sensitivity. The danger of identifying implied tasks is that there may be information components that do not have the same time sensitivity and do not specify or imply a task to be completed. However, they may affect the planning and preparation decisions of other message components.

Specified and implied tasks may be part of any component or paragraph of any particular mission planning products. By convention rather than policy, they are usually found in paragraphs two and three of the mission products. Therefore the first place the planning staff should search for task specification is in these paragraphs.

## G.	CLASSIFYING DISTRIBUTION PARAMETERS

Using the concepts in the preceding sections, a system designer can approach designing a software system to support automated message distribution. First, however, the object type that the system will be managing has to be defined. The object is a data packet that has to be flexible enough to handle multiple, variable-sized cells of information.

The object has to be homogenous enough to be managed like every other data object in the system. Which makes managing data records over a peer-to-peer network more predictable. The class object also has to be as flexible or heterogeneous enough to allow for variable sized content within the storage cells. Internal content of the packets need to contain enough information such that if an external management system needs to retrieve information from the object to determine how to handle it, the function interface between the system and the object behaves as expected, supplying the information that differentiates the selected behavior.

A valuable view of the system design approach is to look at the object as a well-defined class object that is managed by an independent system process. The contents of the object are defined below.

H. CONTENT

1. Labeling

  a. *Higher Mission ID*

In order to maintain the organization of the many tasks that are extracted from higher unit mission products, the mission that is being developed needs to be assigned by the developing unit. Intuitively, any subset text of a document that is ported from one physical or logical location, separate of the parent text, needs to be able to identify where it came from. A manageable local ID scheme can be used to identify this task such as unit, Julian-date, and another local number. In short, there has to be a way to recompose decomposed mission products when they are transmitted in parts on a network.

  b. *Mission Product Type*

Another cell of information that can communicate information to the receiving unit, as well as help to flag the content for storage and display organization, is the mission product type. The three primary types of messages expected to be transmitted across the network are OPERATIONS ORDERS, WARNING ORDERS and FRAGOS. Creating a flag that aids the application in identifying the original message type, simplifies the re-composition of the message.

  c. *Paragraph*

A paragraph identifier label identifies whether or not the content comes from the Situation, Mission, Execution, Service Support or Command and Signal Paragraph.

d. *Subparagraph Levels 1 and 2*

The paragraphs dictate which of the first level paragraph labels is available to select and set as the level-one marking. The level-two subparagraph labels are a subset of the level one marking. Because the labels are exclusive sets, there should never be a conflict of labels. Also if context-sensitive labeling is used, there should be no mislabeling errors.

Labeling, as used here, only serves the purpose of attaching administrative notes to the labeling. There is no automated function attached to this note. The idea is simply to allow the transmitting unit the flexibility to explain any peculiarities with a particular text message. For example, a message having no subparagraph labels because it does not fit into the conventional format may need some explanation.

e. *Modifiable Flag*

An optional function flag can be coded into the application that restricts the receiving unit from modifying the content of a message component is the modifiable flag. This can be done for reasons known only to the sender, the receiver or both. If this function is enabled, the receiver should be made aware of the flag being set. The message label can be used to explain the reason for the modifiable flag being set. Table 2 describes the object components of a message object, as viewed from an external management system's view.

Variable/Object Identifier	Type	Size	Content
HUID	String	Variable	The Issuing Unit ID string two levels up
UID	String	Variable	The Issuing Unit ID string two levels up
Mission Product Type	Binary Flag Set	Two Bits	Flag set that determines the type of mission product the message part is for.
ParagraphID	Binary Flag Set	Three Bits	
SubparLevel	Binary Flag Set	Two Bits	
SubParID	Binary Flag Set	Three Bits	
Distribution Flag	Binary Flag Set	1 Bit	
Note	String	Variable	
Address Reference	32 Bit Address of Distribution component	4 Bytes	
Content	String	Variable	
Date	16 Bit Value	2 Bytes	Date of Message Creation
Original Message	String	Variable	

Table 2: Message format for task data record

2. Distribution Control

a. *Broadcast*

Controlling the network traffic has multiple benefits for the network resources and users of a distributed information system. Reducing the footprint of the communications transmission reduces the amount of waste on the network. Broadcasting sends every message packet to listening node on the network without regard for whether it is meant for their subnet. In a switch-based network, the communications media utilization is based on hardware addresses of the intended recipients.

In mobile networking, one of the obstacles to switch-based networking is transmitting on mixed-media networks. Switching does not mesh well with air-based media. Therefore the benefit of switch-based networks is limited however it still has some value for reducing network traffic.

b. *Multicast recipient list*

Just as one addresses electronic mail messages, being able to select recipients by some distinguishing factor such as their name or unit identifier, has great value. This not only helps the network infrastructure to control the communications footprint, but also helps filter out messages that are not pertinent to the mission of the unit.

3. Updating and Integrity

a. *Updating*

In order to maintain information integrity in this dynamic environment, mechanisms have to be inserted that allow the system to update itself whenever information is changed. There are two ways this can be done. The first is by the receiving, lower-level nodes polling the sending node for changes to the content or labels. If the polling node encounters modified postings, it automatically downloads the changed content and posts it to the query storage base of the receiving node.

The second method is to establish triggers in the sending-unit database that prompts the retransmission of message packets whenever the content or label is modified. There is however a danger in this method that needs to be addressed. Transmission of the content results in transferring ownership of the content and the ability to modify the labels or content, to the receiver who may do so to meet his or her own planning requirements.

Once a mission task is assigned, changing all but minor details of either the content or the label can create information management conflicts for the recipient of the message because they may have already modified the message packet to suit their needs and created document shells from their collection of information. This is not much different from what occurs now in mission planning, although it can have further impact on the way in which automated information management schemes are employed.

### 4.	Policy and Security Issues
#### a.	*Mission change closeout*

Because of the way mission requirements are developed, changes occur often, whether the mission information is developed manually or with the aid of an information system. Planning is not performed in a vacuum. However to the personnel who react to the changes in requirements it sometimes appears as if the planning staff is unaware of how much execution task changes impact the lower level receiving unit's preparation tasks. Regardless of how the information is developed, there has to be a cutoff point for changes to mission requirements. This is not a technology issue but a leadership-awareness issue.

#### b.	*Document closeout*

Related to the mission change closeout is document closeout. Planning staffs spend a great deal of effort to produce mission documents and yet changes even to production mission orders is an open-ended concern. This is another policy and leadership awareness concern. Receiving-unit leaders make

decisions with great impact based on the belief that the documents they have in hand are the way the mission will be executed. Concerns about open-ended changes create apprehension and anxiety among subordinate leaders that the plans they develop are not the tasks that are going to be executed. This may result in the soldiers that they lead having less confidence in the plans. Documents must be closed out at a reasonable time window prior to mission execution to allow leaders and soldiers to gain confidence in the plans they are supposed to execute.

5.   Security of Equipment and Information

Security of the equipment that facilitates information management warrants the type of security that applies to encryption devices and secure tactical radios common in Army vehicles and planning environments. This is mentioned as an obligatory note, in order that the reader can be aware that any proposed automated information management infrastructure can become a valuable, intangible asset to the unit utilizing it, and also to enemy forces who may want to exploit the information.

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VI. SYSTEM ANALYSIS AND APPLICATION REQUIREMENTS

A. INTRODUCTION

1. Purpose

In this chapter we introduce requirements for automated data sharing systems that support the processing of information passed by higher-level commands to tactical-level units.

2. Overview

The original concept driving the study is a peer-to-peer dynamic data sharing application. An example of a well-known peer-to-peer application, Napster®, which permitted had allowed music aficionados to share downloaded music with each other. The idea is that if one user has possession of a data object in an indexed file, then anyone can acquire it, provided that both of the users are logically associated with the same network. The application acts as a catalog of objects, a symmetric, distributed application, and a data management system interface application.

Based on this paradigm, each node/user is responsible for managing their own data and controlling who can or cannot access it. For converting the concept for military operational use, the object in question is a labeled task message stored as a data record instead of a music file. Additional functionality provides the user with the capability for organizing, controlling redistribution, sorting, and converting to mission documents.

B. BUSINESS CONTEXT

Assuming that there is an adequate argument to place automated planning tools in the hands of lower level tactical planning personnel, the most direct way to generate user requirements is to create a user scenario that maps software requirements to operational needs. A software requirements framework

can be used by developers to focus on the requirements of the proposed data-management application, which generates system and subsystem functions that they can transform into a software architecture for a design-engineering project to develop the application.
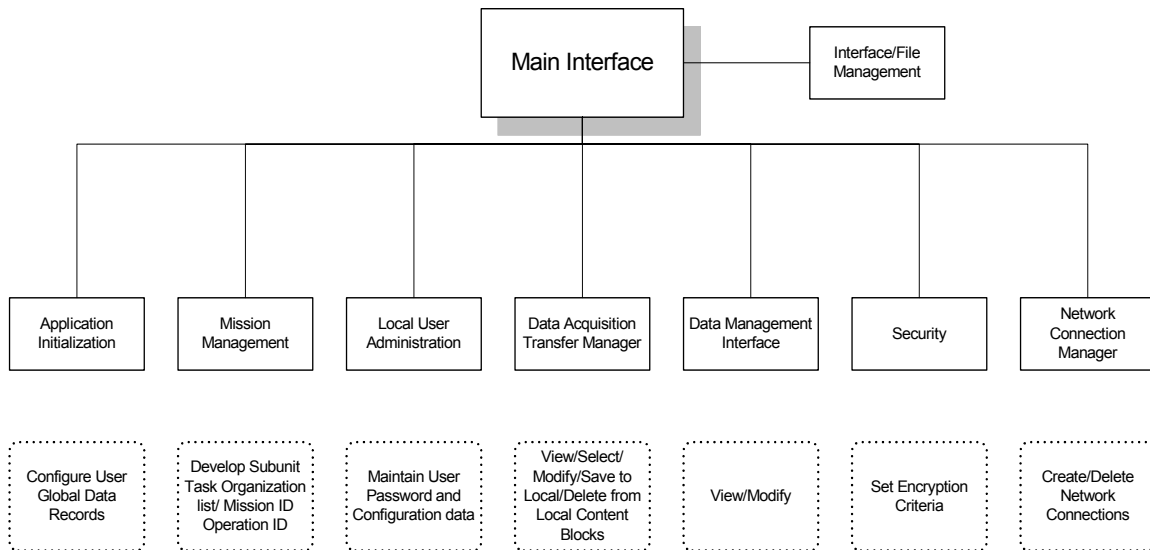
C. GENERAL DESCRIPTION

Figure 5: Application architecture model

a. *Product Functions*

The general functions of the product are to manage tactical data objects to facilitate task-level object sharing between users, as peer-to-peer clients within a client-server, managed environment. The components of the system, viewed as self-contained, integrated components that export functions to other parts of the application, are the application component, the graphical user interface (GUI) component and the data management component.

b. *Application Component*

The application component's core function is to take user requests and translate them into function calls that interface with both the data management system and the instance data records that the system manages. If

necessary, the system must autonomously negotiate network connections with peer nodes in order to acquire messages and append them to a temporary data store. This implies a requirement for a set of interfaces that manage the information that is used to support the core function of the application.

Using the preceding example, automating the network connections implies managing the network configuration data store that facilitates component-to-component interaction to resolve the network addresses of needed information. Additional configuration interfaces include sub-unit identifications, task organization structures that can enhance the interaction between the user and the system.

c.   *Interface Component*

The graphic interface manages how the user interacts with the applications and data records. The high-level functions of the GUI are designed to manage the user's authentication and configuration, mission configuration, network configuration, passwords, along with facilitate data acquisition, document management, and security administration.

d.   *Data Management Component*

Data management goals are to integrate two or more database tables across specific missions. There are two message boards that the data management component controls; the temporary table and the local posting table. This component is also concerned with querying other data tables for pertinent messages.

The temporary data record table is used for modifying content or labels, and selecting messages for posting to the local posting table. An additional function of the data management component is to set distribution requirements for each message. Here, the data management component can interface with the task organization management component to select from a list of sub-units that should receive the listed message. Part of the query function's

requirements is to check the distribution list and flag authorized messages before transmitting them. Only flagged messages are authorized be transmitted.

The network connection list allows the data management component, and more specifically the data acquisition function, to dynamically select which database the user chooses to acquire message data from. This function is independent of the appropriateness of the authority to access the data messages. Authorization should be handled by different components. Functionality within the data management component should allow the user to dynamically change the address reference of the peer node to another address, considering the dynamic environment.

e.   *Data Engine*

The data engine manages the interaction between the application and the data it manages for the user. It needs be able to access remote postings, a local, temporary data store and the local distribution data store.

One of the application's functional needs is to query database indexes for message postings. The interface should allow the user to select the messages he or she wants to download from the list of posted available messages, and post the messages to a temporary storage area.

Once the remote postings are selected and saved to the local temporary store, data functionality should allow the modification of the data contents and labels, which effectively changes the automated decision as to how the information will be displayed.

f.   *Data Conversion*

The data conversion component interacts with the local temporary table to recompose selected messages into a mission document framework. The intent of the labels of the message blocks is to aid in the determination of the message type and sorting of the order of the message.

D.   USER CHARACTERISTICS

This application is targeted towards two potential groups of primary users within the combat arms community. The enlisted service members of the United States U.S. Army, ranking between private and sergeant, with two to eight years of service are the first group. This user group is young, comfortable with computer technology in general and familiar with applications that feature a menu driven, GUI environment.

This group is also knowledgeable of the current generation of commercial software products and communications hardware and software, such as Ethernet and TCP/IP. They are familiar with the current office productivity suites, like Microsoft Office 2000® and can usually troubleshoot simple-to-fix operating system, device drivers and hardware problems.

The second group is the junior officer group, ranking between second lieutenant and captain. This group is also young and has between one and eight years of service, a similar knowledge base as the junior enlisted service members and some have bachelor degrees in science and engineering disciplines. Most will have been required, in undergraduate schooling, to use computer technology to fulfill education requirements.

For both of these groups, automation and information management are an accepted part of their environments. They are unaware of a world in which computer technology and information are not available to them. They believe that most problems can be solved as long as they have the technology to acquire information.

E.   USER PROBLEM STATEMENT

The automation environment is not mature for lower level tactical units. The computer resources are available and generally meet the performance requirements for current software technology needs. The network operating system (NOS) environment is stable and robust enough to support peer-sharing applications. However, the software development process has catered to high-level units to the detriment of the lower level units.

Lower-level tactical users do not have adequate data management software technology to acquire, manage and redistribute data using the available hardware technology. The information processing capabilities are limited and unreliable. Managing these processing tasks takes more man-hours than most units have available to allocate to it.

F.   USER OBJECTIVES

The user's high-level objectives are to create accurate and relevant mission products in a timely manner, using acquired or created task data records. Additionally, changing requirements dictate that the system needs to be flexible to process changes.

If an automation application is used to aid in the mission development process, then it must also be flexible to changes.

The user wants to save time and resources, so that the resources can be allocated to other preparation tasks.

G.   GENERAL CONSTRAINTS

- Any system designed for use by service members in the field must be a menu-driven application.
- The configuration functions that associate the user to an established network must be intuitive, and easily located and executed.
- Critical configuration functions must be semi-autonomous. Applets that assist the user in configuring or reconfiguring critical services should be made available.

H.   FUNCTIONAL REQUIREMENTS

The functional requirements list the user or application events that the application must execute. The following is an initial listing.

1.   Convert data to mission document; The purpose of the application is to decompose large documents into smaller messages for timely transmission. The terminal goal is to be able to recompose the messages into documents.

2.   Save Mission documents; Application management function.

3.   Load Mission Documents; Meet requirement to retrieve saved documents for review and printing.

4.   Connect to peer nodes; The user must be allowed to dynamically modify the connections.

5.   View Peer Nodes; Allows user to determine what nodes he has configuration data for.

6.   Create mission data; This user function is essential to the purpose of the application.

7.   Delete local data records; The user needs to select from a list of data records which ones to delete.

8.   Modify local data; The user needs to select individual data records to modify.

9.   Post local data; Allows user to set distribution information for local data

10.   Save data records; Allows user to save data records separate of the mission documents. Data can be retrieved at a later date.

11.   Set Distribution; Allows user to set distribution information for local data

12.   View Local Data; This user function is essential to the purpose of the application.

13.   Add messages to local post; A select function must exist as part of the view remote data function. An add function reviews the add flags and adds the selected messages to the local posting board.

14.   Challenge and authenticate local users; There must be a 'run once' process that allows the initialization of a user before the first use of the application.

15.   Add local users; Initial user can add other users. Users should be able to manage their own files but not other users.

16.   Delete local users; Initial user can delete other users. Application should query user for disposition of saved files.

17.   Add remote data to local storage; A select function must exist as part of the view local data function. A delete function reviews the delete flags and removes the selected messages.

18.   View Peer Data Posting; The user must be able to connect and authenticate himself to a peer node. The remote system checks the users right against a distribution list for each task and downloads for viewing only those messages that meet the criteria.

19.   Add remote users; The application must maintain a list of active, authorized users and passwords. When a remote user attempts to connect to a local user's posting board, the application checks the list prior to accepting the connecction. An appropriate authentication response should be sent to the sending node if a connection attempt is rejected.

20.   Challenge and authenticate remote users; The application must maintain a list of active, authorized users and passwords. This allows the local user control of who logs on and off of the machine.

21.   Delete remote users; The local user must be able to view a list of remote connections and user, select connections to disconnect.

22.   Select and download peer data; Once data is downloaded for viewing, the user must select the data messeges he wants to append to his local posting board.

I.   INTERFACE REQUIREMENTS

1.   Graphical User Interface

The GUI requirement established for this implementation is based on the Windows Application Programming Interface environment. A window-based interface guides and directs the user to high-level user functions of the application. The major functions of the system are accessed as a list of component menu items, which make function calls to the application components and operating system. See Figure for component organization associated with the interface organization.

2. Application Programming Interface

The Application Programming Interface (API) target for a Windows-based implementation should be Windows 2000/XP platform APIs. By targeting the leading edge of the software technology, developers have some lead-time for integrating the application into the tactical computing base.

3. Communications Interfaces

The system should have full compatibility with the Internet. System developers can assume that complex communications configuration issues cannot be solved quickly or effectively in a tactical environment. Developers should also be mindful of the unique challenges of a tactical operating environment. Critical to the success of a design implementation in this environment, will be the ease with which the user can shutdown, restart and re-associate with peer nodes.

4. Software Interfaces

In addition to making system calls to the operating system through the application-programming interface, the networking suite may reference a local or network-based naming service, depending on how node addresses are resolved in a Dynamic Host Configuration Protocol (DHCP) environment.

J. DESIGN CONSTRAINTS

1. Standards Compliance

The communications protocols external behavior must comply with open standards. Currently, the U.S. Army uses two standards for communications, X.25 and Transmission Control Protocol/Internet Protocol (TCP/IP). The trend is toward developing with TCP/IP for most applications because it is an open standard. The use of TCP/IP creates a security concern because of compatibility with current civilian standards.

2. Hardware Limitations

Current hardware limitations are based on the expected average hardware platform in the field. The application should be targeted toward the current capabilities of desktop workstations or ruggedized notebook platforms, with abundant storage capacity, an Ethernet type connection and possibly a USB or PCMCIA adapter for wireless connectivity.

K. OTHER NON-FUNCTIONAL REQUIREMENTS

1. Security

Considering the proposed usage and the sensitivity of the information being exchanged, security warrants equal consideration as every other design issue. Security of the operational data as it is transmitted and security of the user authentication data are top-level design issues.

2. Reliability

System reliability is key to acceptance of automated applications. The ability to recover from errors and system downtime is very important to the application's perceived reliability.

3. Maintainability

The application should be learnable and maintainable by the application's user. Consideration should be given to using script files that make the application easy to install, configure, maintain and troubleshoot. File and directory conventions should be designed to ensure that the file paths are found by the application without frequent intervention by the user.

4. Portability

It is a possible that the application may need to be ported to another operating system environment. The application architecture as currently

proposed does not support ease of portability. One option, a web based interface, improves portability tremendously. The cost of doing this, however, may be losing functionality options that are unique to the proprietary environments such as Windows and Linux.

5.   Extensibility

The application must be designed with extensibility in mind. There are planned improvements mentioned in the summary that can potentially take advantage of specialization for existing application classes that support the application.

6.   Reusability

The components of the application should be designed with reuse as a consideration. The application components are design to support the objectives of the user within the application framework that is proposed. However, components may be accessed through well-defined interfaces for product improvements.

7.   Application Affinity/Compatibility

The application should be compatible with the Windows API or with one of the common web browsers if using a markup language for designing an interface, because the most common OS environment the United States U.S. Army service members is familiar with is the series of Windows OS environments and most.

There is a trend developing in the Unix/Linux communities to develop applications, and a standard application-programming interface for Linux Products. If this trend continues and the U.S. Army desired to port the application to a Linux environment, there will be considerable work to redesign the application. This is a design risk.

8.   Serviceability

The software application and the hardware platform containing it must be serviceable by trained U.S. Army personnel. The software serviceability is related to its reliability.

L.   OPERATIONAL SCENARIOS

A scenario for developing a use case involves the user logging into the application by identifying himself and authenticating his identity with a password. The system keeps track of the files, and possibly the operating system, will display the files the user has access to. The user either creates a local data file or selects a previously created local file. The mission identifier and label are set when the file is read into memory. The user selects the file he wants to load.

The user may select to display the messages in the local temporary data store or attempt to acquire new messages from a selected peer node and append them to the same store. The user chooses to check a peer node for new messages and selects the peer node. The application queries the node and returns to the requesting system a response by showing the messages that are authorized for distribution. The user selects the messages he wants to save and appends these queries to the temporary store and closes out of the query applet.

The user returns to the display and begins to modify each message label or data cell as needed and then saves the messages to a temporary storage file. Once the temporary data is stored, the user can opt to select messages to be posted to a distribution list or convert the data to a document.

If the user opts to convert the data to a document, the document is saved as a word-processing document that is associated with a data storage file. If the user decides to post the messages to a distribution list, the user selects the distribution applet, which displays the temporary messages. The user selects each message and cycles through the distribution options, which associate distribution flags with each message. The user can then post the messages and continue to manage the data. Figure 5 shows the high-level interaction between the user and the application interface.

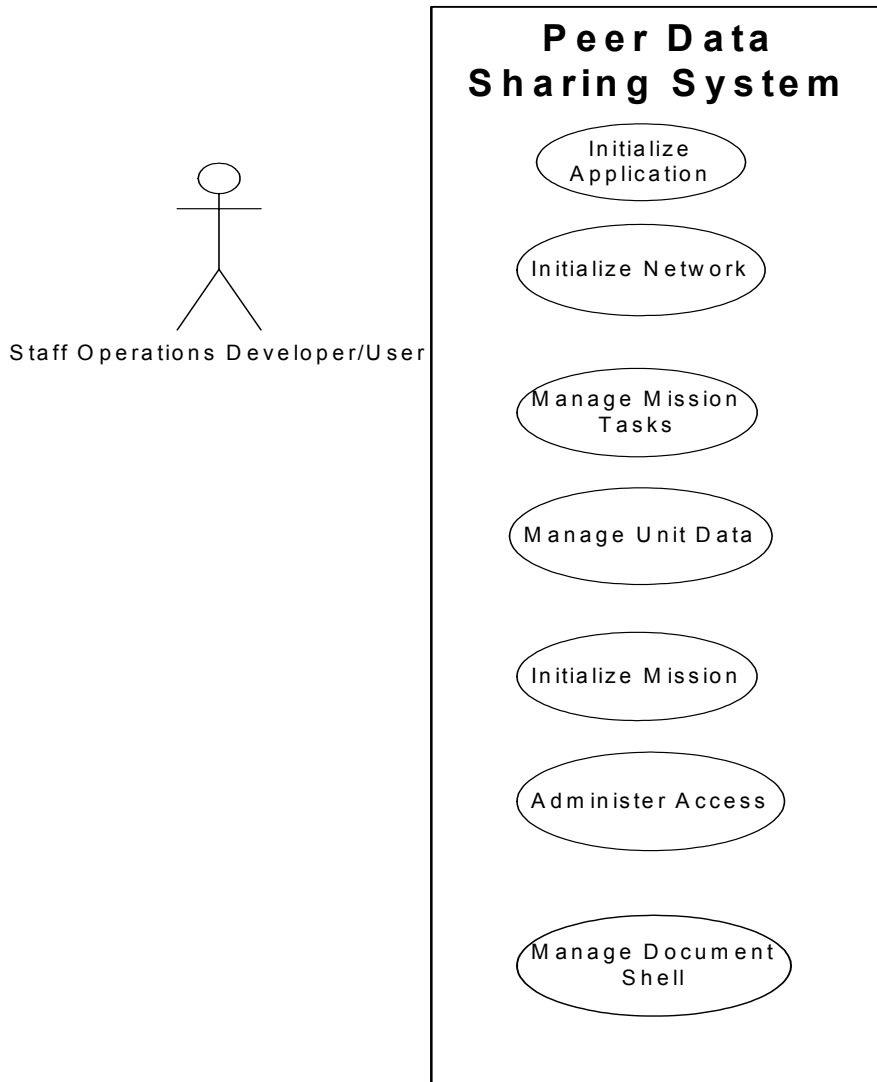Figure 6: User interface model

M.   SOFTWARE COMPONENTS

Figure 4 identifies the software components from which the functions of the system identified. The functions below the components refer to the component they are expected to interact with.

N.   FUNCTIONS LISTING

The functions listed in Table 3 are derived from the functional requirements stated in paragraph H, of this chapter. The list of functions matches the user's operational processes with application requirements.

Public Function: matchAuthentication()   Menu Item: Interface Menu: Application Initilization Trigger   Navigation: Interface: Administration to password check function
Public Function: getFile()   Menu Item: Open   Interface Menu: File Management Interface   Navigation: File   Interface: Application component system call to an Operating System function
Public Function: saveFile()   Menu Item: Save   Interface Menu: File Management Interface   Navigation: File   Interface: Application component system call to an Operating System function
Public Function: saveFileAs()   Menu Item: Save As   Interface Menu: File Management Interface   Navigation: File   Interface: Application component system call to an Operating System function
Public Function: newFile()   Menu Item: New   Interface Menu: File Management Interface   Navigation: File   Interface: Application component system call to an Operating System function

Public Function: printFile()
Menu Item: Print
Interface Menu: File Management Interface
Navigation: File
Interface: Application component system call to an Operating System function
Public Function: closeMission()
Menu Item: Close
Interface Menu: File Management Interface
Navigation: File
Interface: Application component system call to an Operating System function
Public Function: ExitApp()
Menu Item: Exit
Interface Menu: File Management Interface
Navigation: File
Interface: Application component system call to an Operating System function
Public Function: initMission()
Menu Item: Create Mission
Interface Menu: Mission Management Interface
Navigation: Mission
Interface: Function call to Mission Management component to initialize mission variables
Public Function: getMission()
Menu Item: Load Mission Data
Interface Menu: Mission Management Interface
Navigation: Mission
Interface: Application component system call to an Operating System function to read mission variables into application from data file.
Public Function: saveMissionDat()
Menu Item: Save Mission Data
Interface Menu: Mission Management Interface
Navigation: Mission

Interface: File Management system call to an Operating System function to write mission variables into data file from current mission information.
Public Function: saveMissionDatAs() Menu Item: Save Mission Data As Interface Menu: Mission Management Interface Navigation: Mission Interface: File Management system call to an Operating System function to write mission variables into data file from current mission information.
Public Function: showOutConnections() Menu Item: View Local Connections Interface Menu: Network Connection Interface: Local Connections List Navigation: Network Interface: Function Call to Network Management Component
Public Function: createSocket() Menu Item: Add Peer Connection Interface Menu: Network Connection Interface: Local Connections List Navigation: Network Interface: Function Call to Network Management Component
Public Function: deleteSocket() Menu Item: Delete Peer Connection Interface Menu: Network Connection Interface: Local Connections List Navigation: Network Interface: Function Call to Network Management Component
Public Function: showInConnections() Menu Item: Show Remote Connections Interface Menu: Network Connection Interface: Remote Connections List Navigation: Network Interface: Function Call to Network Management Component
Public Function: networkConfig() Menu Item: Configure Local Connection Interface Menu: Network Interface: Local Configuration Interface

Navigation: Network
Interface: Function Call to Network Management Component
Public Function: addRemUser()
Menu Item: Add Remote Users
Interface Menu: User Manger: Remote Users Tab
Navigation: Users
Interface: Function Call to Network Management Component
Public Function: delRemUser()
Menu Item: Delete Remote Users
Interface Menu: User Manger: Remote Users Tab
Navigation: Users
Interface: Function Call to Network Management Component
Public Function: showRemUsers()
Menu Item: List Remote Users
Interface Menu: User Manger: Remote Users Tab
Navigation: Users
Interface: Function Call to Network Management Component
Public Function: addLocalUser()
Menu Item: Add LocalUsers
Interface Menu: User Manager: Local Users Tab
Navigation: Users
Interface: Function Call to User Manager Component
Public Function: delLocalUser()
Menu Item: Delete Local Users
Interface Menu: User Manager: Local Users Tab
Navigation: Users
Interface: Function Call to User Manager Component
Public Function: showLocalUser()
Menu Item: View Users
Interface Menu: User Manager: Local Users Tab
Navigation: Users

Interface: Function Call to User Manager Component
Public Function: showLocalData() Menu Item: View Local Data Interface Menu: Data Management Interface: Local Data Tab Navigation: Data Manager Interface: Function Call to Data Manager
Public Function: modifyLocalData() Menu Item: Modify Local Data Interface Menu: Data Management Interface: Local Data Tab Navigation: Data Manager Interface: Function Call to Data Manager
Public Function: postData() Menu Item: Post Local Data Interface Menu: Data Management Interface: Local Data Tab Navigation: Data Manager Interface: Function Call to Data Manager
Public Function: setDistr() Menu Item: Set Distribution Interface Menu: Data Management Interface: Local Data Tab Navigation: Data Manager Interface: Function Call to Data Manager
Public Function: viewPostList() Menu Item: View Post Interface Menu: Data Management Interface: Local Data Tab Navigation: Data Manager Interface: Function Call to Data Manager
Public Function: setPeerQuerySelect() Menu Item: Peer to Query Interface Menu: Data Management Interface: Remote Data Tab Navigation: Data Manager Interface: Function Call to Data Manager

Public Function: queryRemote()
Menu Item: View Remote Data
Interface Menu: Data Management Interface: Remote Data Tab
Navigation: Data Manager
Interface: Function Call to Data Manager
Public Function: saveSelData()
Menu Item: Select and Save Remote Data
Interface Menu: Data Management Interface: Remote Data Tab
Navigation: Data Manager
Interface: Function Call to Data Manager

Table 3: Application functions

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VII. SUMMARY AND RECOMMENDATIONS

A. SUMMARY

In this thesis we assess the need for providing automated application solutions for use by the U.S. Army for mission planning and preparation for low-level tactical units. The scope of the assessment is limited to how leaders and staff officers at each echelon of command below division-level pass information to lower echelons of the units at each level.

An analysis of the technological environment shows that the U.S. Army has the computer hardware, software and networking capability to support networked peer applications to facilitate data sharing. The current and future generations of soldiers are comfortable with and understand the technological environment much better than past generations.

Analysis of U.S. Army organizational structure illustrates that mission planning and development is complex. Its complexity grows as the size, type and number of units grows with the preparation for each mission. Additionally, the probability of mission planning and preparation errors grows.

B. CONCLUSION

The U.S. Army continuously conducts successful combat and combat support missions around the world. One of the reasons for the operational successes is our combat leaders' understanding of battlefield dynamics, such as time and space. Time is a critical resource and if managed well can yield an advantage over an adversary.

The public expects the U.S. Army to execute very difficult missions with few errors and few casualties. This creates an environment in which leaders will incorporate any technology that will give them an operational advantage. If the Army invests in automated mission planning and development applications for tactical units below brigade level, then it is possible that the return will be a mission preparation time advantage in the form of better execution results from the tactical units.

C.   RECOMMENDATIONS FOR FURTHER RESEARCH

1.   Movement

The orderly movement of large tactical units from one location to another is an immense task. As a product improvement, a tool that would have value to tactical planners is an automated applet that can take a list of vehicles, a set of time and distance parameters, and calculate movement order data. Movement orders were not mentioned in this thesis because they are not considered to be a core mission-planning product. Tactical movement is, however, a significant event.

2.   Data Portability

Data portability was not discussed in this thesis. However, the U.S. Department of Defense (DoD) is concerned about information reuse, information integration, and synergy. One of the approaches the DoD has pushed for in the past has been a universal standard for data-format properties. This has turned out to be a very large task because there are so many data items already in use, each with their own semantics and properties. Along these lines, one should develop data item requirements before implementing the database management system.

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